

INFLUENCE OF HIGH-FAT DIET ON BONE PROPERTIES OF RATS

Gabriela Yanagihara (1), Roberta Shimano (1), Antônio Shimano (1), João Manuel R.S. Tavares (2)

1. Universidade de São Paulo, Brazil; 2. Faculdade de Engenharia, Universidade do Porto, Portugal

Introduction

The role of fat in bone mass and strength is still poorly understood. There are reports of an increased risk of fractures in obese elderly individuals [1]; however, there is not always a decrease in bone mineral density (BMD) [2].

The aim of this study was to evaluate BMD and mechanical strength of bones of ovariectomized rats fed with a high-fat diet.

Methods

This study was approved by the Ethics Committee of our Brazilian Institution (process n° 188/2013). Thirty-two female wistar rats with body mass ranging between 50 and 60 g were studied. The rats were equally divided into 4 experimental groups: I) SD-Sham -rats submitted to sham surgery and fed with standard diet; II) HFD-Sham -rats submitted to sham surgery and fed with high-fat diet; III) SD-Ovx -ovariectomized rats fed with standard diet; IV) HFD-Ovx -ovariectomized rats fed with high-fat diet. SD groups received AIN-93 diet [3] and HFD groups received modified AIN-93 diet containing 60% Kcal saturated fat [4]. Surgery was performed at 5th week of the experiment and after 90 days, the rats were then killed by an overdose of anaesthesia. The humeri bones were evaluated by dual energy x-ray absorptiometry (DXA) to analyse BMD, and by mechanical test to analyse maximal load and stiffness. Three-dimensional images were obtained by computerized microtomography (microCT) for qualitative visualization. Statistical analysis was performed using SPSS™ software, and the generalized linear models with bonferroni adjustment was used to evaluate the effects of the variables under study on the bone properties.

Results

The OVX surgery ($p < 0.001$) and the high-fat diet ($p = 0.026$) resulted in lower BMD of the proximal metaphysis of humerus. The surgery/diet interaction was not significant ($p = 0.946$) for BMD (Figure 1-left). The surgery, diet and surgery/diet interaction did not influence the maximal load of the humerus. The OVX surgery ($p < 0.001$) and the high-fat diet ($p = 0.002$) resulted in higher stiffness (Figure 1-right); however, the surgery/diet interaction did not influence this variable ($p = 0.998$).

Discussion

Our results demonstrate the negative influence of high-fat diet on bone tissue of ovariectomized rats, decreasing their density and modifying their mechanical behaviour.

From the results obtained, it can be inferred that the high-fat diet intake can make the bones stiffer. The change in the BMD and mechanical behaviour occurred due to a significant change in bone microarchitecture, as it is possible to observe in Figure 2. Thus, our results are in-line with other studies suggesting that fat can impair bone metabolism.

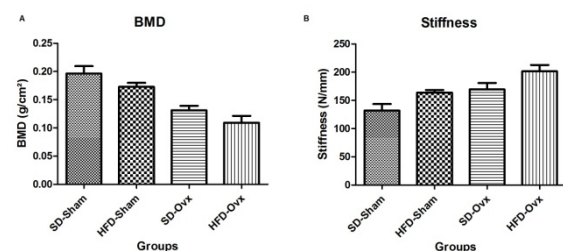


Figure 1: Mean and standard deviation for BMD (on the left) and Stiffness (on the right).

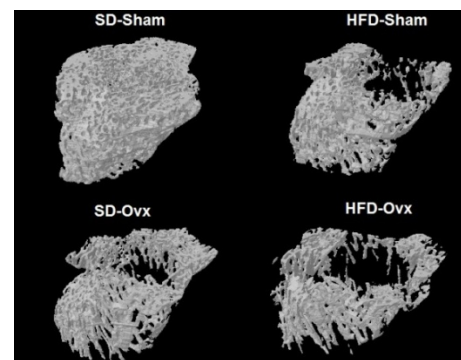


Figure 2: Examples of 3D images for bone microarchitecture.

References

1. Yeung et al, J MagnReson Imaging, 22(2):279-85
2. Shen et al, J Clin Endocrinol Metab, 97(4):1337-46
3. Reeves et al, J Nutri, 123(11):1939-51
4. Yanagihara et al, J Nutr Helth Aging, doi: 10.1007/s12603-017-0871-x

Acknowledgements

This study was supported by São Paulo Research Foundation (references 2014/10733-8, 2014/25879-8 and 2015/26142-1). Authors gratefully acknowledge the funding of Projects: NORTE-01-0145-FEDER-000022 - SciTech - Science and Technology for Competitive and Sustainable Industries, cofinanced by “Programa Operacional Regional do Norte” (NORTE2020), through “Fundo Europeu de Desenvolvimento Regional” (FEDER); and “Processing and Analysis of Scanning Electron Microscopy Images: Application in Biomechanical Study of Bones of Obese and Eutrophic Rats” cofinanced by Universidade do Porto and Universidade de São Paulo.

